
SCIENCE & TECHNOLOGY

The exception, of course, is Western civilization. The breakup of the Roman Empire into competing towns, cities, duchies, and finally nations resulted in conditions conducive to innovation that still prevail. Technology has thrived in the West, Wesson says, because all modern attempts to reconstitute the Roman Empire by would-be Caesars (Charlemagne, Louis XIV, Napoleon, Hitler) have failed. It is doubtful, he says, that these "very special circumstances" have been duplicated on many other planets.

Loch Ness Monsters

"Atmospheric Refraction and Lake Monsters," by W. H. Lehn, in *Science* (July 13, 1979), American Association for the Advancement of Science, 1515 Massachusetts Ave. N.W., Washington D.C. 20005.

In the fall of 1958, fisherman H. L. Cockrell spent several nights in a kayak on Scotland's Loch Ness hoping to catch a glimpse of the "monster" long said to inhabit the waters. On his third night out, he saw a "slightly whiskery and misshapen" creature swimming toward him. Suddenly, a small squall rose on the lake; when it passed, Cockrell observed a stick, four feet long and one inch thick, floating on the surface.

Lehn, a professor of electrical engineering at Canada's University of Manitoba, writes that Cockrell and others who have reported sightings of "lake monsters" (at Lake Manitoba and Lake Winnipeg, as well as



*From The Mystery of the Loch Ness Monster.
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Sightings of mysterious lake monsters may be caused by atmospheric conditions that seemingly alter the shapes of common objects.

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Loch Ness) may have been fooled by visual distortions that occur frequently at lakes in cold temperate regions.

Temperature inversions—i.e., when a layer of warmer air hovers over colder air—are common at lakes, where the water is often several degrees cooler than the air. In an inversion, Lehn says, horizontal light rays tend to refract downward as they strike cooler, denser air. Light rays reflected from a single point on an object may be bent in varying degrees as they pass through air of different temperatures. The viewer, says Lehn, assumes that what he sees has come to him in a straight (unrefracted) line but in fact perceives a single point as several. If the inversion is buffeted by an offshore breeze, the distorted image may appear to grow, shrink, or vanish. If it is stationary, the observer's movement, however slight, can alter the shape and size of the object.

In the Loch Ness sighting, Lehn suggests, it is probable that the stick Cockrell later observed had been magnified by a refraction caused by a temperature inversion over the lake (77 percent of the Loch Ness Monster sightings occur in May through August, the months when lake temperature is well below air temperature). When the storm struck, the inversion was disturbed, thus allowing Cockrell to view the stick in its normal aspect.

RESOURCES & ENVIRONMENT

Treasures from the Sea?

"Marine Resources: The Economics of U.S. Ocean Policy" by James A. Crutchfield, in *The American Economic Review* (May 1979), 1313 21st Ave. South, Nashville, Tenn. 37212.

The world's ocean mineral resources are only valuable insofar as their availability helps keep down the prices of land-based supplies. That being the case, writes Crutchfield, a University of Washington political scientist, "the present value of most mineral resources in the marine environment (with the obvious exception of oil and gas) is at or near zero."

The technology to locate and mine ocean mineral formations does not yet exist. And most dissolved minerals are present in concentrations too small to extract efficiently. The exceptions are salt (30 percent of the world's supply comes from the sea), magnesium, and bromine; but high-grade deposits of the latter two are more cheaply exploited on land. Dredging nets a significant \$80 million worth of sand and gravel per year worldwide. Tin, aluminum, iron, and zircon are also dredged up, but in amounts too meager to have much effect on world prices.

Yet, on the ocean floor, the much-publicized ferro-manganese "nodules" (usually ranging from walnut- to potato-sized) seem promising as a source of copper, nickel, cobalt, and manganese. Indeed, several major industrial combines plan to prospect for nodules. These